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(54) Piston Rings; Lip Type Seals

(57) A sealing ring which has an annular part 36 from which extend inner and outer lips 40, 38. The sealing ring is mounted between the cylindrical surface of a bore and a piston slidable in said bore. The outer cylindrical surface (50) of the annular part 36 is normally slightly remote from the surface with which the outer lip sealingly cooperates. The annular part 36 is deformable so that the outer cylindrical surface (50) can come into sealing contact with the above mentioned surface, in order to improve fluid tightness.

FIG.2

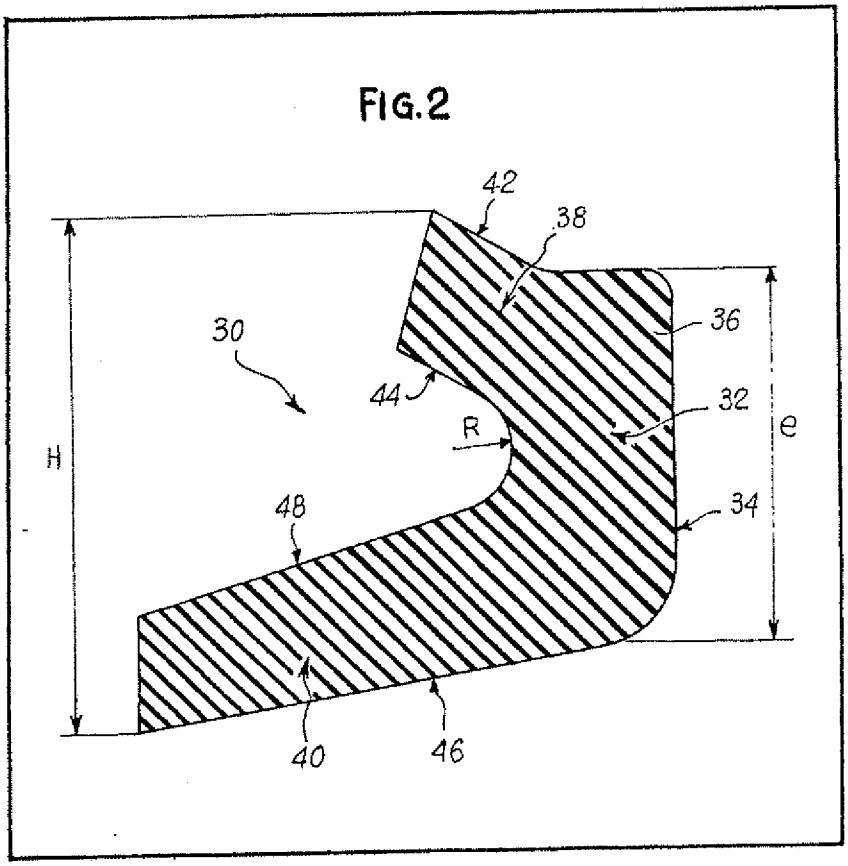

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FIG.1

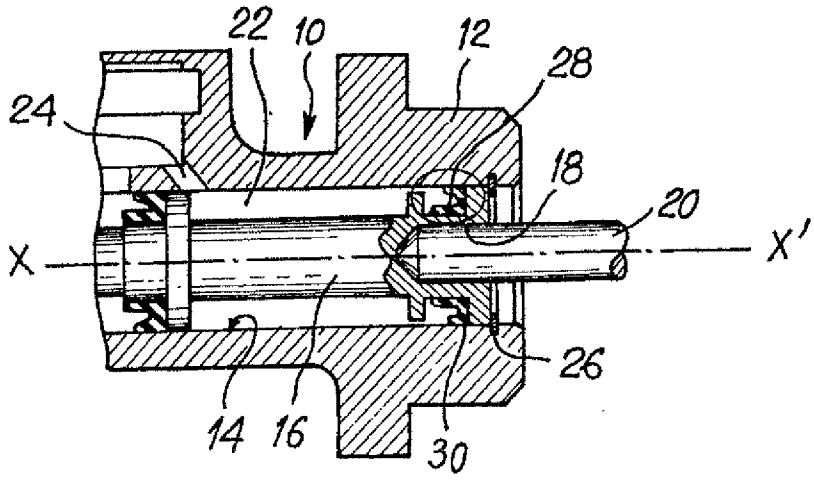


FIG.2

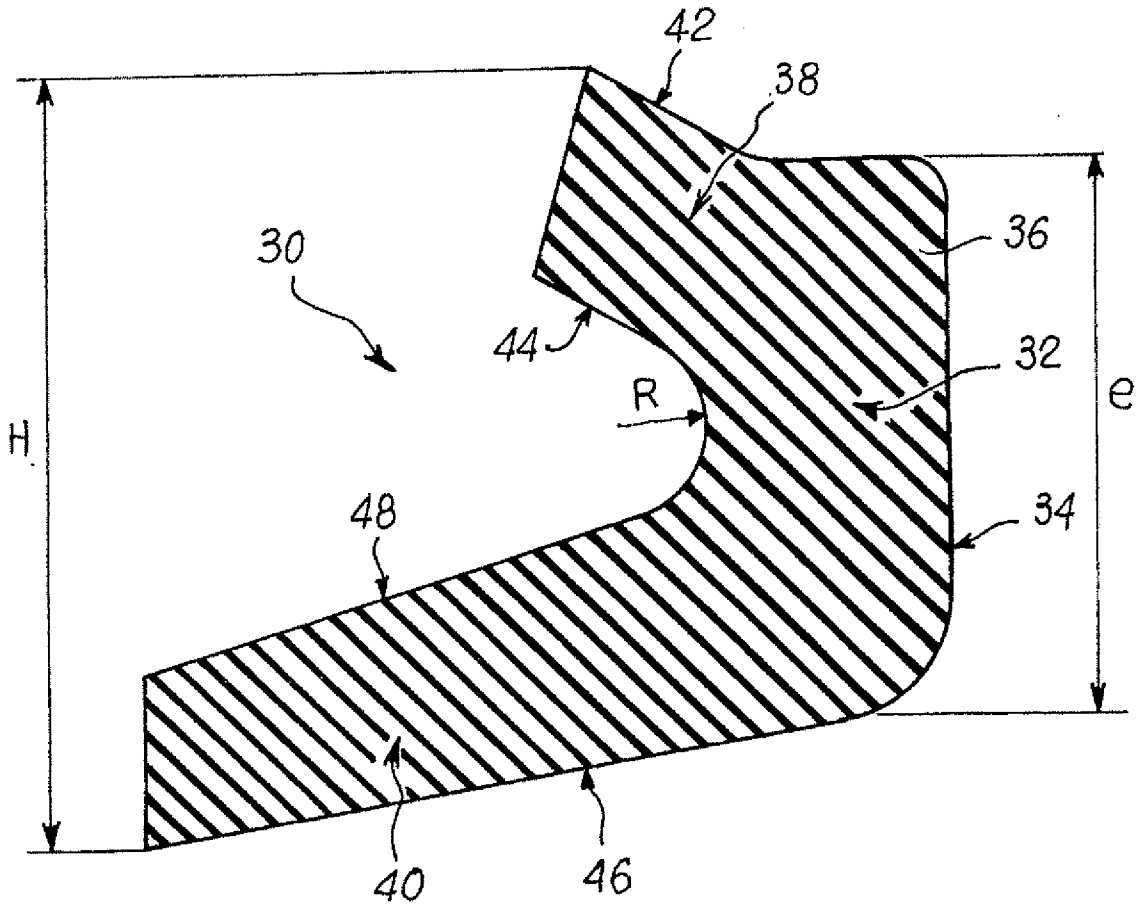


FIG. 3

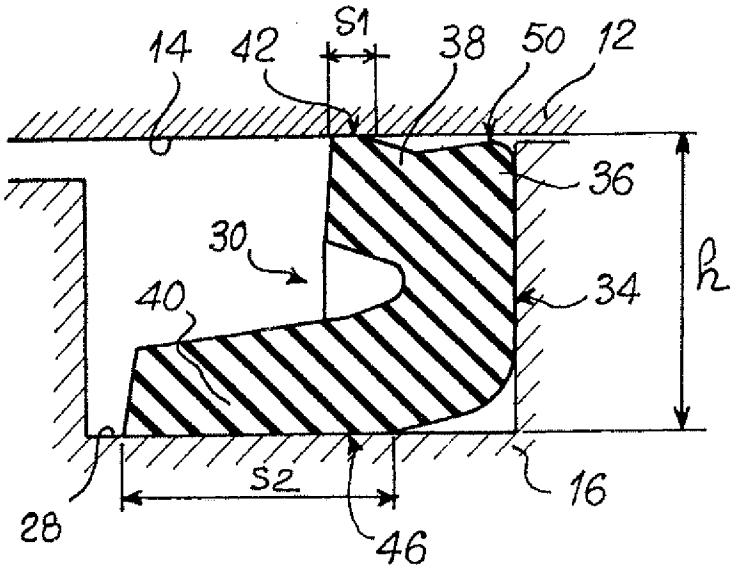
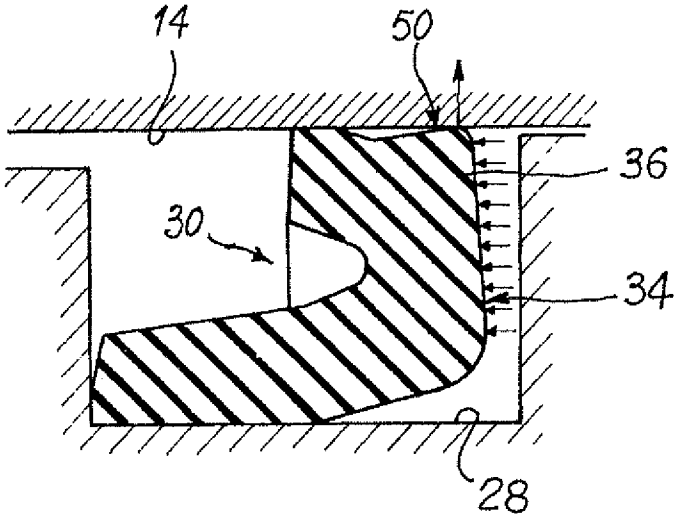


FIG. 4



SPECIFICATION

Sealing Ring and a Sealing Device Using Such a Ring

The invention relates to a sealing ring and a sealing device using such a ring.

Some known rings or seals are adapted to be mounted between the bore of a casing and a piston movable in the bore in order to seal the bore from the exterior. Such rings or seals are e.g. conventionally used in a hydraulic master-cylinder for insulating the hydraulic circuit from atmosphere. Usually the rings are mounted in an annular groove in the master-cylinder piston near the thrust rod and comprise an annular member having a first surface bonding a flange, collar or the like, the rings having an outer lip and an inner lip connected to that surface of the annular member opposite the first surface. Each lip has an outer edge which co-operates in sealing-tight manner with a matching contact surface comprising the wall of the bore and end of the groove.

During operation, a ring of the aforementioned kind normally provides adequate sealing, but it has been found that if there is a depression in the hydraulic circuit, e.g. during evacuation of the circuit during filling or draining, that surface of the ring disposed on the same side as the thrust rod remains at atmospheric pressure whereas its other surface is subjected to the negative pressure of the hydraulic circuit.

The result is that the outer lip of the ring may tilt, which may result in air bubbles being introduced into the hydraulic circuit, which is undesirable.

On the other hand, a general problem posed by this kind of ring is to substantially reduce the frictional forces during the motion of the piston in the bore.

The aim of the invention, therefore, is to provide a sealing ring and a sealing device using the ring so as to obtain good sealing-tightness between the hydraulic circuit and atmosphere. Another aim of the invention is to provide a ring and sealing device for reducing the frictional forces between (a) the ring and (b) the piston and bore.

Accordingly, the invention provides a sealing ring of resilient material for providing a fluid tight separation between the inner cylindrical surface of a bore, and the outer surface of a cylindrical element slidably mounted in said bore, said sealing ring being adapted to be mounted in an annular space of one of said bore and cylindrical element, said ring comprising an annular member having a first surface which bounds a flange, the annular member also having a second face opposite said first face with an outer lip and an inner lip connected to said second face, each lip having an inner edge and an outer edge, the outer lip extending in a direction slightly inclined towards the exterior, with respect to the axis of the annular member, the outer edges of both lips being adapted to co-operate with facing surfaces of the bore and of the cylindrical element, said sealing ring being characterised in that the flange is so dimensioned that after being mounted in said annular space its outer peripheral surface is normally remote from the facing surface of the bore or of the cylindrical element, said flange being deformable radially towards the exterior with respect to the axis of the said annular member, when the difference between the pressures to which are submitted the first and second faces respectively reaches a predetermined value, so that said outer peripheral surface comes into sealing engagement with said facing surface, the latter permanently co-operating in a sealing tight manner with the outer edge of said outer lip.

The invention also provides a sealing device between a casing formed with a bore and a piston movable in the bore, the device comprising a sealing ring according to the invention, mounted so as to be coaxial with the piston and disposed in an annular groove formed in the bore of the casing or in the piston. The sealing device is designed so that the distance between the bottom of the groove and the annular facing surface of the bore or piston is made less than the maximum distance between the outer edges of the lips of the ring in the free state, the distance also being greater than the radial thickness of the annular member, the outer edge of the outer lip co-operating in sealing-tight manner with the cylindrical surface of the bore and the outer edge of the bottom lip co-operating in sealing-tight manner with the cylindrical surface of the piston.

The invention will now be described and other features and advantages of the invention will be more clearly understood from the following detailed description, which refers to the accompanying drawings in which:

Fig. 1 shows an embodiment of a sealing ring of the kind according to the invention;

Fig. 2 is a half-section of a sealing ring according to the invention, the ring being in the free state;

Fig. 3 is a half-section through the ring illustrated in Fig. 2, the ring being mounted in a recess; and

Fig. 4 is a half-view substantially identical with that in Fig. 3, in an operating position.

Fig. 1 partially shows a hydraulic pressure generator 10 or master cylinder comprising a casing 12 containing a bore 14, the right end of which opens to atmosphere. Inside the bore, a piston 16 is slidably mounted in conventional manner and has a central cavity 18 into which a thrust rod 20 extends and is actuated in known manner by the brake pedal. The piston has a peripheral annular groove 22 having a length such that it is permanently connected to the hydraulic circuit fluid tank (not shown) via a passage 24 in the wall of casing 12.

Piston 16 is held in bore 14 by a retaining ring 26. The portion of piston 16 near the right end has an annular groove 38 containing a sealing ring 30 comprising an annular central member

defining an outer lip in sealing-tight contact with bore 14 and an inner lip in sealing-tight contact with the bottom of groove 28. The sealing ring 30 is adapted to separate the annular groove 22 in sealing-tight manner from the atmosphere.

Fig. 2 is a half-section of a ring according to the invention in the free state. In Fig. 2, 30 is the general reference for a ring comprising an annular member 32. The annular member 32 has a first surface 34 on the right-hand side (in Fig. 2), bounding a flange or collar 36. The ring also has an outer lip 38 and an inner lip 40 connected to the left surface of the annular member. The outer lip 38 extends towards the exterior at an angle relative to the XX′ axis of the annular member. The outer lip has an inner edge 44 and an outer edge 42, the end of which is adapted to co-operate in sealing-tight manner with bore 14. The inner lip 40s′ extends at a slight angle to the interior relative to the XX′ axis of the annular member, and it has an inner edge 48 and an outer edge 46, the left part of which is adapted to co-operate with the bottom of groove 28. In the preferred embodiment now described, by way of example only, the top lip of the ring, when in the free state, is inclined at approx. 30° relative to the XX′ axis, whereas the inner lip has an inclination of the order of 10° relative to the same axis.

Ring 30 is designed so that the top lip 38 and the bottom lip 40 each have a thickness which is substantially identical with the axial thickness of the annular member, thus increasing the possibility of elastic deformation of the ring relative to a ring where the annular members are larger than the lips. Finally, the inner edges of the outer and inner lips are connected to the annular body to form a substantially toric connecting surface, having a radius of curvature R which is between half and a third of the axial thickness of the cylindrical member 32.

According to the invention, the ring is made of relatively flexible resilient material, so that lips 38 and 40 can be radially deformed in order to reduce the frictional forces between the ring and the bore and piston. The flange or collar 36 is also radially deformable towards the exterior by pivoting around the ends of the lips of the ring, when pressure is exerted on its surface 34.

Fig. 3 shows the sealing ring in the position which it occupies after being fitted into the annular groove 28 of the piston 16 in Fig. 1, when the piston is at rest or moved to the left. The sealing ring 30 is dimensioned so that the maximum radial distance H between the outer edges of its lips 38 and 40 (see Fig. 2), when the ring is in the free state, is greater than the distance *h* between the wall of bore 14 and the bottom of groove 28. On the other hand, distance *h* is greater than the radial thickness of the annular member 36 of the ring (compare Fig. 2). Consequently, the sealing ring 30, when mounted in groove 28, is compressed so that the outer edge of the outer lip 38 is in sealing-tight contact with the wall of bore 14 along a cylindrical surface S1, and the outer edge of the inner lip is in contact with the bottom of the groove along a cylindrical surface 52. Surface 34 of the ring comes in contact with that edge of groove 28 situated on the atmosphere side. In the position illustrated in Fig. 3, the outer peripheral surface 50 of flange 36 does not come into contact with bore 14.

The axial distance between surface 34 bounding flange 36 and the end of the inner lip is less than the axial length of groove 28. This manner of assembling ring 30, with clearance in groove 28, is particularly favourable since it makes it easier to pivot the angular member 32 and deform the flap, as will be shown hereinafter.

Fig. 4 shows the position of ring 30 in groove 28 when there is a negative pressure in groove 22 due e.g. to evacuating the hydraulic surface during filling or draining. At such times, there is a negative pressure in groove 28, which is connected to groove 22. On the other hand, surface 34 of the ring is subjected to atmospheric pressure and consequently its flange 36 is radially deformed towards the exterior, the deformation being caused by anti-clockwise pivoting of the annular member after the end of the bottom lip has come in contact with the edge of groove 28 facing it. The outer peripheral surface 50 of flange 36 comes in contact with bore 14 to produce additional sealing-tightness, thus obviating the aforementioned disadvantages.

The embodiment of the sealing device incorporating the ring according to the invention mainly comprises a bore co-operating with a piston, the ring being disposed in an annular groove of the piston. Of course, however, the ring could be disposed in a groove in the bore without departing from the scope of the invention.

Claims

1. Sealing ring of resilient material for providing a fluid tight separation between the inner cylindrical surface of a bore, and the outer surface of a cylindrical element slidably mounted in said bore, said sealing ring being adapted to be mounted in an annular space of one of said bore and cylindrical element, said ring comprising an annular member having a first surface which bounds a flange, the annular member also having a second face opposite said first face with an outer lip and an inner lip connected to said second face, each lip having an inner edge and an outer edge, the outer lip extending in a direction slightly inclined towards the exterior, with respect to the axis of the annular member, the outer edges of both lips being adapted to co-operate with facing surfaces of the bore and of the cylindrical element, said sealing ring being characterised in that the flange is so dimensioned that after being mounted in said annular space its outer peripheral surface is normally remote from the facing surface of the bore or of the cylindrical element, said flange being deformable radially towards the exterior with respect to the axis of the said annular member, when the difference between the pressures to which are submitted the first and

second faces respectively reaches a predetermined value, so that said outer peripheral surface comes into sealing engagement with said facing surface, the latter permanently co-operating in a sealing tight manner with the outer edge of said outer lip.

2. Sealing ring according to claim 1, characterised in that said flange is radially deformable by pivoting around said annular member.

3. A sealing ring according to claim 1 or to claim 2, characterised in that the inner lip extends in a direction slightly inclined towards the interior with respect to the axis of the annular member.

4. A sealing ring according to any one of claims 1 to 3, characterised in that the inner lip and the outer lip have substantially the same thickness, which is substantially equal to the axial thickness of the annular member.

5. A sealing ring according to any of the preceding claims, characterised in that, when the ring is in the free state, the inner edges of the outer and inner lips are connected to the annular member to form a substantially toric connecting surface having a radius of curvature between half and a third of the axial thickness of the cylindrical member.

6. A sealing ring according to any of the preceding claims, characterised in that the outer lip is shorter than the inner lip, the outer lip, when in the free state, being inclined at an angle of approximately 30° with respect to the axis of the annular member, and the inner lip having a smaller inclination relative to said axis.

7. A sealing ring according to claim 6, characterised in that the inner lip, when in the free state, is inclined at an angle of the order of 10° relative to said axis.

8. A sealing device between a casing formed with a bore and a piston movable in the bore, the device comprising a sealing ring according to any one of claims 1 to 7, mounted so as to be coaxial with the piston and disposed in an annular groove formed in the casing or in the piston, the device being characterised in that the distance between the bottom of the groove and the annular facing surface of the bore or piston is made less than the maximum distance between the outer edges of the lips of the ring in the free state, the distance also being greater than the radial thickness of the annular member, the outer edge of the outer lip co-operating in sealing-tight manner with the cylindrical surface of the bore and the outer edge of the bottom lip co-operating in sealing-tight manner with the cylindrical surface of the piston.

9. A sealing device according to claim 8, wherein the inner lip is longer than the outer lip, characterised in that the axial distance between the flange and the end of the inner lip is less than the axial length of the groove.

10. A sealing device according to claim 8 or claim 9, characterised in that the groove is defined in the piston, the outer edge of the inner lip co-operating in sealing-tight manner with the bottom of the groove.

11. A sealing ring substantially as described and as shown in the accompanying drawings.

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